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ABSTRACT

The purposes of this study were to determine the feasibility of group testing of conservation and examine the differential performance of students drawn from various populations. The effects of three factors were examined: grade level (2, 4, 6), SES (disadvantaged, advantaged, and race (Black, White, Latin). (Author)

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THE DEVELOPMENT OF A GROUP FILM TEST OF CERTAIN PIAGETIAN CONSERVATIONS

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The purposes of this study were to determine the feasibility of group testing of conservation and examine the differential performance of students drawn from various populations.

The effects of three factors were examined, grade level (2, 4, 6), SES (disadvantaged, advantaged), and race (Black, White, Latin).

Group testing of concept formation

Many researchers investigating the Piagetian conservations have used an individual testing procedure patterned after the clinical method of Piaget. They have generally employed physical materials which can be manipulated and they have usually established a standard testing procedure acceptable for experimental research. Although Goldschmid and Bentler (1968) have developed a standardized conservation test using manipulative materials, individual testing is very time consuming. If feasible, it would be most desirable to have available a group test for assessing conservation.

Nelson (1969) developed a group test for assessing number and length conservation with first-grade children. He utilized an overhead projector for presenting items and the pupils marked their answers in response booklets. The correlation of scores on this test with scores on an individually administered test of the same concepts was .51.

Becker (1969) found no significant differences between individual and group scores on four selected standardized psychoeducational tests. Subjects were 169 kindergarten, first-, second-, and third-grade pupils. Items were presented by projecting designs on a screen using transparencies or by use of a closed circuit television system. This study lends support for the use of group testing of children on cognitive variables.

Brown (1967) developed a reliable group test of children's ability to conceptualize. The test was prepared for use in an elementary science curriculum project. The test measured its ability to attend to a task, to remember logically, to detect similarities and to use all these skills in the conceptualizing process.

Delacy (1967) administered a group paper and pencil test of Piaget's length conservation task to 140 children aged 6-12 years with 10 boys and 10 girls at each age level. Two three-inch reference lines were given on cardboard and the subject was given paper to see if the lines were equal. Next four plastic sheets of Mueller-Lyon illusion arrowheads (45°, 55°, 65°, 75°) were used, one at a time, to distort the equality. There was no difference in the degree of illusion created by the various arrowheads. The subjects could not reliably conserve length with this test until 12 years old. Some inversion of performance was noted for the ten-year-olds and this was explained in terms of shift from iconic to symbolic reasoning.

The results of these studies indicate that conservation can be assessed using group testing. While all of these studies were not designed primarily to test the applicability of group testing of a wide range of conservations, the evidence presented suggests that such a test might be feasible.

Projection techniques in presenting concept formation tasks

O'Bryan (1969) prepared a 16 mm. film test of length, area, continuous quantity solid, and continuous quantity liquid. Subjects were 80 first-grade pupils. The basic conservation question was tape recorded but subsequent follow-up questions were asked by the experimenter. A child was judged to be a conserver only if he gave a solid reason for his correct response. Otherwise he was classified as a nonconserver. By insisting that Ss give reasons for their answers, O'Bryan introduced a source of variation. It would seem more advisable to devise a test which was standardized throughout and did not rely on evaluation of Ss oral responses. Some Ss may fail to give acceptable responses because they are shy. Comparisons were made between the usual method of individual testing with manipulative materials and

the film presentation. No significant differences were found between the two methods of testing conservations. Along with (Singh, 1968) this study provides strong support for use of filmed presentation of conservation tests.

Yudin (1966) constructed a concept formation test a la Bruner, Goodnow, and Austin (1956). The items were presented using 2" x 2" color slides.

Experimenter variables in concept testing

In constructing a test of the conservations it is imperative that bias due to the testing situation be eliminated. Several sources of bias have been identified and studied.

Bittner and Shinedling (1968) studied methodological problems in measuring conservations of substance in children. The Subjects were 8 male and 8 female S for each of two experiments. Some rather striking results were reported. For first-grade Ss instructional and task variations influence performance; for third-grade Ss the importance lessons. For first-grade Ss the sex of the experimenter was a major source of variation. Female experimenters elicit the best performance for first-grade Ss, but the reverse is true for third-grade Ss. This study deserves replication in light of the small number of subjects. The findings, if true, are of major importance for testing of the conservations.

Hall and Kingsley (1968) criticized the methodological techniques of assessing conservation and found that children in the intuitive phase are very susceptable to experimental suggestion. They report that this can be overcome by using tape recorded verbal instructions.

Fletcher (1967) investigated the extent to which language is a factor in conservation of number. The subjects were 200 first graders. Responses to traditional conservation of number questions and questions employing an operationally-defined coined word "bimates" were compared. Subjects first received training in the meaning of "bimates." The test consisted of seven equivalent and seven non-equivalent sets of conservation of number problems. The test employed 14 separate devices. Group I subjects were asked "Is this bimates?" Group two was asked "Do we have the same number of red cards and blue cards?"

Silverman and Schneider (1968) investigated the development of the conservation of quantity by a procedure adapted from Piaget's but with a criterion other than verbal report. (The method did not depend upon the child's statements of "more" or "less". The subjects were 147 children aged 4 to

10 years, 66 male, 81 female, from lower and middle class families. The child was shown identical glass jars with different amounts of M and M's and asked, "Which jar has more candy?" Then as the child watched, the experimenter poured a lesser amount into a third jar, which was longer and narrower and placed it next to the jar having the greater amount. Then the experimenter said. "You can have all the candy in one of these jars, whichever one you choose. Which one would you like?" Then, "Why did you pick that one?" The percentages of children at one-year age levels showing conservation conformed closely to Piaget's reports and subsequent replications which used verbal methods. The sex differences within age groups did not achieve significance, there was a trend which suggested that females may develop conservation earlier than males.

Goldschmid and Bentler (1968) have published a conservation test in three forms. The test utilizes manipulative materials which are available together with the test as a Conservation Assessment Kit. As an individually administered test, it measures conservation of number, length, continuous quantity, mass, area and volume. Forms A and B consist of 12 items each. Form A and B can be used as pre- and post-tests while Form C can be used as an indication of the generalization of conservation. A significant finding is that children's more, less or same responses correlate above .90 with their explanations. Thus, it would not seem necessary to utilize the easily misinterpreted verbal explanations of children in assessing conservation.

Socioeconomic status and level of cognitive development

Bozarth (1968) examined the relationship between socioeconomic status (SES), conserving status, achievement and intelligence of 209 fourth-grade children. He found that there was a significant difference between high and low SES levels on conservation of liquid quantity in favor of high SES. He further reported that conservers generally had higher intelligence and better achievement in school science.

Skypek's (1967) study measured differences in the development of cardinal number conservation concepts among children from differing socioeconomic environments. Three Piagetian conservation tasks of discontinuous quantity, provoked correspondence, and spontaneous correspondence were the criteria used. The subjects were 120 students selected randomly from kindergarten, first, and second grades in 4 schools in a metropolitan school system. Schools were selected according to the socioeconomic status of the urban neighborhoods they served. The relationship of socioeconomic status to concept-test scores was highly significant

with differences favoring middle class. All subtests were significant except conservation of spontaneous correspondence. The relationship of CA to concept test and subtest scores are highly significant with differences favoring children from successively older age groups. No significant difference was found for race, except on the conservation of provoked correspondence (favored white). For the middle class sample, correlations of age and score were positive and significant for all three conservation subtests, following Piaget's theory. The developmental pattern of cardinal number conservation for the low status Ss was erratic. Only 53 of the 120 subjects were in the same stage on all 3 tasks. Among low status Ss a discernable but erratic pattern of retardation in the development of number conservation concepts was noted.

Farnham-Diggory (1969) experimentally analyzed the ability to integrate information when "triggered" by symbolic cues in three types of situations: verbal-integrating actives with logographs, maplike-integrating spatial ideas, and mathematical. The subjects were 212 Negro and White children aged 4 to 9 years.

Study One

The purpose of this study was to test the feasibility of assessing conservation using a film test administered to students in a group setting. If such an approach would give comparable results, the saving in time and expense of testing would be considerable. For this study, a thirty-five minute color super 8 mm movie was made.

The use of motion pictures is ideally suited for a test of conservation since conservation items involve a transformation and thus movement. It would be difficult to present conservation items adequately using slides or the printed page because of the necessity to show movement. Added advantages of the motion picture approach over using display materials lies in the standardization of presentation and ease of administration. The movie was used to administer an eleven item test of conservation of number, length, mass, discontinuous quantity and continuous quantity. To administer the test to a class, response booklets were distributed and the room was partially darkened. E read from a script accompanying the movie as the pupils watched the screen. The projector was turned on and off for each item.

The response booklets featured a picture of a star, flower and ball as shown in Diagram 1.

or

Diagram 1

The class was instructed to mark the star if this one had more (question varied with item) as the pointer indicated the one on left or top, to mark the flower if this one had more, as the pointer indicated the one on the right or bottom, and to mark the ball if they both had the same (question varied with item).

A second instrument used for individual testing used the concrete materials seen on the screen by the group. The parallel test was administered by E in the usual one-to-one procedure. E recorded the oral responses of the child. The description of the items in the two tests can be found in the Appendix.

The group film test was administered to 148 first-grade subjects ranging in age from 6 to 7 years of age. In addition, the individual manipulation test was administered to a sub-sample of 40 subjects. The sample was drawn from middle class schools and included a wide range of abilities. The ability of the subjects was approximately normally distributed.

Results of Study One

As can be seen from Table 1, most of the items were near the .50 difficulty level. Item 7, which was answered correctly by 85 percent of the Ss on the group film testing was a measure of one-to-one correspondence while all other items were measures of conservation. The conservation of length items were more difficult than the conservation of number items which agrees with the findings of other researchers. The correlation between the scores from the

individual and group testing for the subsample was .86, indicating excellent agreement. The KR 20 reliability for each test was above .91.

There was excellent agreement of proportion correct on the two tests with most item proportions differing by no more than two or three hundredths.

Table 1

Proportion of Correct Responses

Item	Individual Testing	Group Testing
1	.58	.59
2	.58	.56
3	.48	.46
4	.58	.55
5	.45	.49
6	.48	.50
7	.70	.85
8	.65	.71
9	.50	.48
10	.45	.46
11	.53	.53

Thus group testing of conservation using a film presentation appears feasible. The efficiency gained by such testing could be benificial for both researchers and educators.

Study Two

The purpose of this study was to develop a comprehensive test of the conservations and determine differential results due to SES, grade level, and race. For this study, a twenty-one item film test was constructed. The first form of the test was administered to 150 subjects and revised on the basis of the results.

Description of the test

The test consisted of twenty-one items and two practice items. The items were similar to those in Study One except

that additional conservations were tested. Also included were items on conservation of area, weight and volume. Five items were included showing unequal sets, length or quantity to guard against response set on "same." For example, two identical containers were shown with one having more colored liquid than the other. Then the contents of the one with less was poured into a taller, thinner container so that the height of liquid was higher. In all twenty-three items, the subjects were told either one container had more or they had the same before the transformation. The content of the items is shown in Table 2.

Table 2

Description of the Film Test

a	Practice, two sets of three each
b	Practice, set of three and set of seven
1	Number, eggs and egg cups
2	Number, unequal sets
3	Number, two rows of discs
4	Number, two rows of discs
5	Length, horizontal placement
6	Length, unequal rods
7	Length, vertical placement
8	Discontinuous quantity, beans in jars, unequal
9	Discontinuous quantity, beans in jars
10	Discontinuous quantity, beans in jars, unequal
11	Mass, clay balls, pancake shape
12	Mass, clay balls, sausage shape
13	Continuous quantity, equal
14	Continuous quantity, unequal
15	Area, two rectangular regions, one changed
16	Area, two rectangular regions, one changed
17	Area, two rectangular regions, one changed
18	Weight, clay on balance scales
19	Volume, sets of blocks
20	Volume, sets of blocks
21	Volume, clay in water

In an attempt to minimize cueing during testing and to standardize procedures, an audio tape was used in presenting all verbal information. Once booklets were distributed, the remaining testing was governed by the tape and film. The children recorded their responses in test booklets similar to those used in Study One. They marked a star, a flower, or a key to indicate a choice of "more" (two cases) or "same."

In each item, the wording was appropriate to the materials, i.e., for continuous quantity, "Here you see two containers with the same amount of juice." (Transformation) "If you think this one has more juice mark the star. If you think this one has more juice mark the key. If you think both containers have the same amount of juice mark the flower." The "more", "same" parts of the question were alternated to eliminate bias from responding to the last choice mentioned.

Test characteristics

As a measure of the reliability of the test, KR 20 coefficients were calculated and found to be above .90. As an indication of the discrimination of the items, the correlation of each item with the total test score was computed separately for each grade. The discrimination indices were quite high, with many in the .6 to .7 range.

The proportions of correct responses for the items for each grade are shown in Table 3.

Table 3

Proportions Correct by Item for Each Grade

Item	Grade Two	Grade Four	Grade Six
1	.654	.767	.912
2	.721	.860	.929
3	.946	.986	.967
4	.797	.942	.969
5	.716	.867	.932
6	.926	.944	.987
7	.659	.863	.934
8	.566	.865	.960
9	.527	.847	.954
10	.664	.819	.916
11	.615	.923	.967
12	.522	.877	.945
13	.505	.767	.801
14	.578	.851	.936
15	.517	.777	.832
16	.478	.791	.852
17	.485	.795	.865
18	.566	.872	.923
19	.522	.835	.918
20	.598	.853	.945
21	.480	.735	.753

The subjects for this study were chosen from the Gary, Indiana schools. The school system was chosen because it contained sufficient numbers of subjects to fill each of the 18 cells of the factorial design. A total of 1286 students were tested and 1127 were used in the analysis of variance. Some students had to be omitted because of incomplete data. Classes were chosen so that each of the 18 cells in the design would have at least 50 subjects. In all, 35 classes were tested. A 2x3x3 factorial design was used to determine the performance by SES, (disadvantaged, advantaged), grade level (2, 4, 6) and race, (Black, Latin, White).

Results of Study Two

The 2x3x3 analysis of variance yielded significant main effects ($p<.01$) for all three factors with no significant interactions. The ANOVA is shown in Table 4. The main effect means appear in Table 5.

Table 4

Analysis of Variance, 2x3x3

Source	MS	D.F.	F-Ratio	Prob.
Total	25.851	1127		
Between	535.058	17		
A	708.783	1	39.2621	.0000
B	3986.662	2	220.8361	.0000
C	114.208	2	6.3264	.0023
AB	4.104	2	.2273	.7994
AC	51.179	2	2.8350	.0574
BC	1.345	4	.0745	.9869
ABC	17.377	4	.9626	.5716
Within	18.053	1110		

A Socioeconomic status; disadvantaged, advantaged
B Grade level; 2, 4, 6
C Race; Black, Latin, White

Table 5

Main Effect Means

	1	2	3
A	15.75	17.42	
B	12.69	17.84	19.22
C	16.38	16.13	17.24

There was a large difference between grade two and grade four scores (5.15 points on a twenty-one point test) while the grade four, grade six difference was only 1.36 points. This result was predictable on the basis of Piagetian theory; the grade four and grade six children should be more homogeneous with regard to developmental stage.

One objective in using an audio-visual rather than a paper-and-pencil test was to eliminate bias of results due to test taking obstacles, such as reading difficulty and boredom. Subjects were not required to read and they were attentative throughout the test period. While there were significant differences on the factors of SES and race, it should be noted that the actual main effect scores of the group differed by only one point. In light of these small differences between scores of advantaged, disadvantaged and Black, White, Latin, it can be concluded that the test achieves a high degree of culture fairness.

In attempting to determine the relationship between IQ and achievement measures and the scores on the conservation test, correlations were computed. The correlations ranged from a low of .083 to a high of .277 with most falling in the .19 to .26 range. These correlations are shown in Tables 6, 7 and 8.

Table 6

Grade Two Correlations Achievement with Conservation

Word Knowledge	.157
Word Discrimination	.124
Reading	.205

Table 7

Grade Four Correlations of IQ and Achievement with Conservation

Intelligence - Verbal	.270
Intelligence - Nonverbal	.253
Vocabulary	.279
Reading Comprehension	.247
Spelling	.182
Capitalization	.264
Punctuation	.166
Usage	.219
Arithmetic Concepts	.259
Arithmetic Problems	.243

Table 8

Grade Six Correlations of IQ and Achievement with Conservation

Intelligence - Verbal	.236
Intelligence - Nonverbal	.083
Vocabulary	.211
Reading Comprehension	.231
Spelling	.215
Capitalization	.258
Punctuation	.208
Usage	.165
Maps	.131
Graphs	.193
References	.198
Arithmetic Concepts	.213
Arithmetic Problems	.198

According to Piaget the conservations are acquired at different ages. Consequently, the items in the test should form a unidimensional scale. One item of each type of conservation was selected for use in a Guttman scaleogram analysis. Using second grade scores, the index of reproducibility was calculated to be .80. Second grade was used since children at this age are likely to be conservers of some but not all on the conservations measured. The result indicates that the items selected are scaleable.

DISCUSSION

The two sequential studies reported in this paper describe the development of a group test of conservation. The test is wide range including items from eight types of conservation. While the test has been administered successfully in grades one through six, it is most applicable for grades one and two. It is at this level that children are developing most of the conservations sampled in this test.

Many studies have been performed using the time consuming individual testing. While for some studies individual testing is necessary because of the nature of the study, many others data could more conveniently be collected using group testing.

The use of motion picture techniques has several advantages. First, the procedure is highly standardized. There is no error due to variations in testing time or procedures. Secondly, large numbers of children can be tested at once, resulting in considerable economy of testing time. In individual testing, the child may read in to the question or take cues from the voice inflections of E. With film testing, taped directions can be used, eliminating the opportunity for the child to think a certain response is called for.

If anything, the film test developed for Study Two overestimates the number of conservers. This conclusion is based on a comparison of proportion correct with the results reported in the literature. This may be a function of the items rather than restrictions imposed by film testing. The test would be excellent as a screening device for classroom use.

Many group administered tests place a reading and attention burden on the child. This test does not require any reading. Furthermore, the use of motion pictures stimulates interest and attention is quite high.

Thus it has been shown that group testing using a motion picture presentation with sound is feasible and yields results not unlike those from individual testing with manipulative materials.

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APPENDIX

Description of items - Study one

Item 1. Conservation of Number. Six eggs and six egg cups were shown in two co-responding rows. Ss was asked whether one row had more or whether they both had the same number. Then the eggs were moved close together and the question repeated.

Item 2. Conservation of Number. This item was like Item 1 except that two rows of identical discs were used, six in each row. Those in one row were spread out.

Item 3. Conservation of Length. Two identical rods were placed parallel with ends aligned. S was asked whether one rod was longer than the other or whether both rods were the same length. Then one rod was moved parallel slightly ahead of the stationary rod. Then the question was repeated.

Item 4. Conservation of Number. This item was the same as Item 2 except the discs in one row were moved close together.

Item 5. Conservation of Mass. Two identical balls of clay were shown. S was asked whether one had more clay or whether they both had the same amount of clay. One ball was flattened and the question repeated.

Item 6. Conservation of Mass. This item was the same as Item 5 except one ball was rolled into a sausage shape.

Item 7. One-to-one Correspondence. S was directed to place eighteen table tennis balls into identical jars, one in each jar at a time. Then the S was asked whether there were the same number of balls in the jars or whether one jar had more balls than the other.

Item 8. Conservation of Discontinuous Quantity. Using the two jars with nine balls each the contents of one was poured into a flat container. The S was asked whether the two containers had the same number of balls or whether one had more balls than the other.

Item 9. Conservation of Discontinuous Quantity. Two identical cups were filled to the same height with kernels of corn. The S was asked whether they had the same amount of corn or whether one had more corn than the other. Then the contents of one cup was poured into a tall thin container. The question was repeated.

Item 10. Conservation of Length. This item was the same as Item 3 except longer, thinner rods were used.

Item 11. Conservation of Continuous Quantity. This item was like Item 9 except that colored water was used.